BULLETIN

University of Santa Clara

SCHOOL OF ENGINEERING

UNDERGRADUATE

GRADUATE

PROGRAMS

1963/1964

CALENDAR

First Semester 1962

September 10-12	Undergraduate orientation and registration.
September 13	Undergraduate instruction begins.
September 15	Engineering graduate program registration.
September 17	Engineering graduate program instruction begins.
October 19	Last day for seniors to file for June graduation.
November 1	All Saints Day, academic holiday.
November 21	Thanksgiving holiday commences at noon.
November 26	Classes resume.
December 19	Christmas holiday begins.
January 3	Classes resume.
January 17	Semester examinations commence.
January 25	Semester ends.

Second Semester 1963

February 2	Engineering graduate program registration.
February 4-5	Undergraduate registration.
February 4	Engineering graduate program instruction begins.
February 6	Undergraduate instruction begins.
February 22	Washington's Birthday, academic holiday.
April 11	Easter holiday begins.
April 16	Classes resume.
May 23	Ascension Thursday, academic holiday.
May 24	Semester examinations commence.
May 31	Semester ends.
June 1	Commencement.

Summer Session 1963

June 8	Engineering graduate program registration.
June 10	Engineering graduate program instruction begins.
July 4	Academic holiday.
August 2	Last day Engineering graduate program.

ADMINISTRATION AND FACULTY
SCHOOL OF ENGINEERING

PATRICK A. DONOHOE, S.J., PH.D.
President

WILLIAM C. GIANERA, S.J., M.S.
Assistant to the President

ALEXIS I. MEI, S.J., PH.D.
Academic Vice-President

ROBERT J. PARDEN, PH.D.
Dean

RICHARD K. PEFLEY, M.S.
Assistant Dean

CARL L. BECKER, M.S.
Associate Professor of Electrical Engineering

ROBERT F. BURT, M.S.
Lecturer in Mechanical Engineering

JOHN E. BUSH, M.S.
Instructor in Mechanical Engineering

CHARLES H. DAWSON, PH.D.
Lecturer in Electrical Engineering

EUGENE J. FISHER, B.S.
Instructor in Mechanical Engineering

PETER M. FITZGERALD, PH.D.
Lecturer in Electrical Engineering

EDMUND C. FLYNN, M.S.
Emeritus Professor

BERNARD S. GOLOSMAN, M.S.
Lecturer in Electrical Engineering

HENRY V. HAHNE, PH.D.
Chairman and Associate Professor of Civil Engineering

MAMORU INOUYE, M.S.
Lecturer in Mechanical Engineering

JEROME JACOBSON, M.S.
Lecturer in Mechanical Engineering

DONLAN F. JONES, M.S.
Assistant Professor of Electrical Engineering

ROBERT H. KEYSER, PH.D.
Associate Professor of Civil Engineering

TUCK HOP LEE, PH.D.
Lecturer in Electrical Engineering

HENRY A. MCKENNA, B.S.
Instructor in Mechanical Engineering

ROBERT I. MURRAY, M.S.
Assistant Professor of Mechanical Engineering

HENRY P. NETTESHEIM, M.S.
Chairman and Associate Professor of Electrical Engineering

ROBERT J. PARDEN, PH.D.
Dean and Professor of Engineering

RICHARD K. PEFLEY, M.S.
Chairman and Associate Professor of Mechanical Engineering

JACK A. PETERSON, M.S.
Assistant Professor of Electrical Engineering

MICHAEL A. SAAD, PH.D.
Assistant Professor of Mechanical Engineering

STANLEY F. SCHMIDT, PH.D.
Lecturer in Electrical Engineering

GAIL B. SHOOK, PH.D.
Lecturer in Mechanical Engineering

GEORGE L. SULLIVAN, PH.D.
Emeritus Dean and Professor of Engineering

PETER A. SZEGO, B.S.
Assistant Professor of Mechanical Engineering

HAROLD M. TAPAY, M.S.
Associate Professor of Civil Engineering

GEORGE J. THALER, PH.D.
Lecturer in Electrical Engineering

UNIVERSITY OF SANTA CLARA

ANNOUNCEMENT

OF THE

SCHOOL OF ENGINEERING

1962-1964

THE UNIVERSITY OF SANTA CLARA

LOCATION

The University of Santa Clara, one of twenty-eight institutions conducted by the Fathers of the Society of Jesus, is situated at Santa Clara, on the site of the Mission of the same name, fifty miles south of San Francisco. The City of Santa Clara is contiguous with San Jose which, according to a recent study of the Department of Commerce, is Presidente of the Missions of California.

HISTORY

Mission Santa Clara. On January 12, 1777, two Franciscan Padres, de la Pena and Murguia, planted the Mission Cross and laid the foundations of Mission Santa Clara on the banks of the Guadalupe, a mile and a half from the present University grounds. Two years later a flood destroyed both church and monastery, and the Padres removed the Mission to the second site, two blocks from the present church. There, on November 9, 1781, they laid the foundations of a large adobe church and mission buildings. Three years later, on May 15, 1784, the new church was dedicated by the Venerable Padre Serra, then Padre Presidente of the Missions of California.

Owing to damage by earthquakes in 1812 and 1818, the Padres were forced to build anew and this time selected the site of the present Mission. There, on August 11, 1822, a still larger church was dedicated. With the passing of time the church was largely rebuilt, though the chancel and the interior arrangements remained substantially as originally constructed. The Mission was destroyed by fire in 1926 but was rebuilt in 1927 along the lines of the original structure. The new Mission was dedicated in 1928. The restoration was made possible by the generosity of friends in the Santa Clara Valley as well as friends and alumni of the University throughout the state of California.

In 1836 Mission Santa Clara was secularized and passed from the hands of the devoted Padres into those of politicians, who robbed the Mission of her lands and oppressed or drove away her children. When Rt. Rev. Joseph Sadoc Alemany, O.P., arrived as Bishop of the Diocese of San Francisco in 1850, he found only one Franciscan in charge of the Mission, which had been restored by the American government, though in a sadly reduced form.

Santa Clara College. Desiring to save the remnants of the Mission, and also to start a college to meet the growing need of the times, the Bishop invited the Society of Jesus to Santa Clara. The invitation was accepted and on March 19, 1851, Father John Nobili laid the

foundation of Santa Clara College. In 1857 the degree of Bachelor of Arts was conferred on Thomas I. Bergin, the first to receive that degree from any California college.

During subsequent years the College grew in influence and attendance. Several large new buildings were added and for many years Santa Clara College, in both equipment and scholastic standing, ranked as a leading educational institution in the West. On April 28, 1885, the institution was chartered as a University but continued to be known as Santa Clara College until 1912. It is the oldest institution of higher learning in the West.

THE UNIVERSITY. In 1907 lectures were initiated to prepare students to enter professional courses in law, medicine, and engineering. In 1911 the pre-medical curriculum was established and the law school begun. In 1912 the President and Board of Trustees adopted officially the name "University of Santa Clara."

In 1913 a thoroughly equipped laboratory for engineering was prepared. The outbreak of war in 1914 suspended plans for expansion and it was not until after its close that they were resumed. In 1923 an extensive building program was begun in order to provide an adequate material basis for the University.

Accompanying the building program there has come a corresponding growth in attendance and scholastic work. In 1923 the pre-medical program was restored and a four-year College of Business Administration added. In 1925 the College of Law was increased to four years and the Preparatory Department transferred to a separate campus at College Park, San Jose. In 1926 the University celebrated its Diamond Jubilee and with enlarged facilities and equipment entered upon a program of greater service to the Church and the state.

In 1939 the College of Law was fully accredited by the American Bar Association and the Association of American Law Schools. Developing a program of community service, the College of Business Administration in 1947 offered evening classes to make the services of the business faculty available to people of the area. In 1961 the title "college" was dropped for Business, Engineering, and Law and the word "school" was adopted. Later in the same year the title of the School of Business Administration was changed to School of Business.

During the academic year of 1950-51 the University celebrated its one-hundredth year of service to the community. It was fittingly commemorated by functions of a religious, academic, civic, and social nature.

In 1956 plans were formulated for a modified nursing program designed to give a year of academic work to first year students of O'Connor Hospital. Since the fall of 1961, Santa Clara has been a co-educational institution.

SCHOOL OF ENGINEERING

ROBERT J. PARDEN, PH.D., DEAN

The School of Engineering offers programs leading to the Bachelor's degree and the Master's degree in Civil, Electrical and Mechanical Engineering, and the Master's degree in Engineering Mechanics.

FIELDS OF ENGINEERING

Upon completion of an undergraduate program in engineering, a wide range of opportunities exists in the profession of engineering. This vista is becoming increasingly broad because of the rapid expansion of technology in today's society, and the influence of technology on many activities in business and industry. In addition, engineering has proven to be an excellent background for assignments which in themselves are not necessarily classified as professional engineering. As a result, there are many fields in which an engineering graduate's professional development may take place regardless of his branch of specialization as an undergraduate.

In general engineering practice, in business, industry, and all levels of government there is an unlimited variety of activities appealing to the varied interest of the individual—design, industrial research, development, technical administration, construction, sales and production, to list a few.

The choice of field of engineering specialization need not be made until the middle of the junior year at Santa Clara. During the first two years of engineering, a student is expected to further investigate the fields of engineering so that his choice of a major is made on increased evidence he may accumulate in his reading, his visits to plants and engineering projects, his talks with people who have had experience in the various fields and, in general, a greater knowledge of the variety of opportunities open to engineers.

CIVIL ENGINEERING relates to works in connection with transportation, such as highways and traffic, railways and canals; to structural works, such as bridges, buildings, dams, piers and many other structures constructed of wood, steel or reinforced concrete; to sanitary works and works which have to do with water, such as the collection, purification and distribution of water for a municipal supply; the collection, treatment and disposal of sewage; the drainage of some lands and the irrigation of others. In all of these fields of work, technical knowledge is required for the execution of successful designs, and for proper operation and maintenance.

Electrical Engineering includes the design, construction, and operation of equipment for generation, transmission, and utilization of electrical energy. Electrical engineers are concerned with all phases of the electrical transmission of information such as radio, television and telephone. Data processing equipment and computers used by business, industry and government are included in their major area of interest. Much of the equipment used in maintaining our national security is powered and controlled by electric and electronic mechanisms.

Mechanical Engineering attracts those engineers who are interested in propulsion ranging from hydraulic jets and propellors to rockets; power generation ranging from solar heat engines to nuclear power plants; explosions of all types extending from the housed explosion in the internal combustion engine to free bomb-type explosion; heating, refrigeration and air conditioning ranging in application from human comfort to the cooling of vacuum tubes; structures subjected to motion extending from printing presses and calculators to guided missiles.

Mechanical engineers are concerned not only with the design of this variety of machines, products and equipment, but also with the design and operation of the factories, mills and plants in which manufacturing and processing take place.

Engineering at Santa Clara

Instruction in Engineering was begun in 1910 and the first degree was granted in 1914. Since its inception, Santa Clara has felt that the undergraduate program should primarily include that course work which is considered fundamental to all engineering with a minimum of specialization in the separate branches of engineering. The increasing number of engineers who are working in areas which cross the traditional engineering classifications, would make it appear that further integration will occur.

The Civil, Electrical and Mechanical Engineering degree programs at Santa Clara are accredited by the Engineering Council for Professional Development. This Council reflects the nationwide consensus of the type and quality of programs that will be of most benefit to the individual and the organizations with which he will be engaged.

Buildings and Facilities. The School of Engineering's laboratories are contained in three buildings in the Sullivan Engineering Center. The three units completed in 1960 and a projected lecture, seminar and office building, will house the entire School of Engineering.

The Civil Engineering building includes laboratories for instruction and research in the properties and processing of materials, physical metallurgy, destructive and non-destructive testing, dynamics, solid mechanics, and structural design.

The Electrical Engineering building includes a computer facility which houses digital and analog computers, and laboratories for instruction and research in circuit synthesis, electronics, controls, electromechanical devices and high frequency studies.

The Mechanical Engineering building includes bench laboratories and a high-bay facility for experimentation in the areas of fluid mechanics, hydraulics, thermodynamics, heat and mass transfer, hydrodynamics, propulsion, combustion and power generation. Specific equipment includes a constant level tank and a flexible water distribution system for general experiments, a small wind tunnel, and dynamometer capacity from 7½ to 300 horsepower.

The Undergraduate Program

The three programs in Civil, Electrical and Mechanical Engineering are planned around a common core of courses which will provide:

1. A thorough preparation in the basic sciences of physics, chemistry and mathematics.

2. The general application of these sciences as developed in the engineering fundamentals: mechanics of solids and fluids, properties of materials, thermodynamics, electricity and magnetism.

3. Assistance in further developing the ability to communicate orally, or by written and pictorial presentations.

4. Study in the humanities, including the social sciences, theology and philosophy.

The professional subjects pertaining to the particular areas of Civil, Electrical and Mechanical Engineering are developed primarily in the upper division.

Admission

Freshman

To qualify for freshman standing in the School of Engineering applicants must be graduates of an accredited high school and must present no less than sixteen units including the following:

English	3	Trigonometry	½
Foreign Language (one language)	2	History	1
Algebra	2	Chemistry	1
Geometry	1	Physics	1
		Unprescribed	4½

It is strongly recommended that the unprescribed units be in mathematics, languages, natural or social sciences. Applicants who offer a list of subjects not in accordance with the above will be admitted at the discretion of the Admissions Committee, based on their College Entrance Examination achievement and their high school record.

Entrance Examinations

All applicants for admission to the freshman class in engineering are required to take the following examinations:

The scholastic aptitude test.

Achievement tests in advanced mathematics, and any two of the following: English, Physics or Chemistry.

The entrance examinations are given by the College Entrance Examination Board and are offered at many locations throughout the world. Students living in the West should write to Educational Testing Service, Box 27896, Los Angeles 27, requesting the application form and information on examination dates and locations. Students living in the East should write Educational Testing Service, P.O. Box 592, Princeton, New Jersey.

Examination may be taken on the same or different days, but all tests should be completed by March of the senior year in high school. The Board should be requested at the time the tests are taken to send the scores to the University of Santa Clara.

It is recommended that a test application form and test information be obtained from the College Entrance Examination Board not later than October of the senior year in high school. The procedure for making application for admission to the University may be found on page 53. It is suggested that the application for admission to the University be submitted by April 1.

Freshman Orientation

In addition to the orientation lectures for all freshman students during the three days following freshman registration in the fall, the School of Engineering will present a series of orientation lectures during the first semester for freshmen enrolled in Engineering. The series will include discussions of the engineering profession, information about the various fields of engineering, suggestions on methods of increasing the learning experience, and expansion of the goals of the engineering program.

During the freshman year, engineering students should purchase a slide rule of the log log duplex decitrig type and acquire facility in its use. Every student must be prepared to take a written examination in the practical use of this slide rule by the end of the first semester.

R.O.T.C.

Unless excused for reasons of health or prior military service, all freshman and sophomore students are required to enroll in the Basic Course of the Reserve Officers Training Corps. Students following an engineering program of study who are also enrolled in the junior and senior year Advanced Course will usually require more than the normal four years in the University to obtain a baccalaureate degree.

Admission as a Junior

Admission to the upper division of the School of Engineering will be based on:

A. Satisfaction of the general requirements for admission to the University.

B. A minimum gradepoint in university level work previously undertaken, with special emphasis on science and mathmatics achievement.

C. The student will normally be able to complete a bachelor degree program in four semesters if he presents 65 units including the following minimum subject requirements:

	Minimum No. of Units
Analytical Geometry and Calculus	12
Chemistry (for engineering and science students)	7
Physics (for engineering and science students)	10
Graphics, and engineering materials or surveying	6
Engineering Mechanics — Statics	2
Freshman English 1A-1B	6
Liberal Electives (English, Economics, History, Social Studies, Languages)	12
Public Speaking	2
Unspecified	8
Total	65

ACADEMIC INFORMATION

Student Classification

Class rank in engineering is based upon the number of units earned which are applicable to the engineering degree program. Freshman 0-33, Sophomore 34-66, Junior 67-101, Senior 102 and over.

Semester Schedules

The normal semester schedule is 18 units. No student may carry in excess of 19 units in a semester unless he has Honor Standing and the written permission of the Dean.

Liberal Electives

The Engineering program requires a minimum of 12 units of liberal elective credit in addition to English 1A and 1B, and Speech 1.

Courses may be selected from the following areas:

English	History	Sociology
Political Science	Speech	Psychology
Economics	Language	Philosophy

Academic Requirements

Complete academic requirements for the University are shown elsewhere in this catalogue.

In summary they are:

1. A freshman who has a deficiency of seven grade points will be placed on probation.

2. All other students whose average in any semester falls below a 2.0 (C average) will be placed on probation.

3. A student is removed from academic probation when he earns a C average during the semester he is on probation.

4. A student who does not remove his probation is subject to suspension for a minimum of one semester.

5. A "C" average in all courses with an Engineering School number must be earned in order to be recommended for a degree. Students who have failed to earn this average will be required to repeat low achievement courses.

Honor Standing

Honor standing is granted by the Dean of Engineering each semester to those students who maintain a high scholastic achievement. Students with Honor Standing are normally allowed greater freedom in course selection and the amount of work they can undertake in a semester.

Graduation Honors are awarded by the University based on the work of the undergraduate program.

Normal Time Requirements

The average student will be able to complete a degree program in eight semesters. Those students who are deficient in mathematics, or who must assume part-time off campus jobs, or who add additional programs to the engineering program will require nine or ten semesters.

Requirements for Graduation

The curricula in Engineering require 135 units for graduation. Residence of at least one year immediately preceding graduation is required for the undergraduate degree.

Senior Thesis

The senior thesis provides a student with the opportunity to carry out an original investigation in an orderly fashion, the momentum of progress being supplied primarily by the student's enthusiasm, interest and effort. The project is scheduled throughout the senior year and must be submitted before the student is admitted to his final examinations.

It is felt that a good undergraduate thesis:

1. Should involve an element of originality. It should be an investigation on the frontier of the student's knowledge.

2. Should require an element of design, an element of equipment assembly and utilization of instrumentation and a test program.

3. Should include successful evaluation of results utilizing sound test techniques and application of fundamentals of engineering. It is desirable that the evaluation require an extension of previous information to cope with the thesis project.

The Department Chairman appoints a thesis advisor. The advisor will approve the thesis subject and method of approach, the outline of the thesis project, the initial drafts and final copy of the thesis as the project develops.

UNDERGRADUATE PROGRAM ARRANGEMENT

Freshman

Fall Semester	*R*	*L*	*U*	*Spring Semester*	*R*	*L*	*U*
Theol. 5 (Old Testament)	2		½	Theol. 6 (Life of Christ)	2		½
Mil. Sci. 1 (Basic Course)	2	1	1½	Mil. Sci. 2 (Basic Course	2	1	1½
Math. 3A (Anal. Geom. & Calculus)	3		3	Math. 3B (Anal. Geom. & Calculus)	3		3
Engl. 1A (Comp. & Lit.)	3		3	Engl. 1B (Comp. & Lit.)	3		3
Liberal Elective			3	Liberal Elective			3
Speech 1 (Fundamentals)			2	Phys. 4A (General Physics)	3	3	4
ME. 3 (Engr. Graphics) or	1	6	3	ME. 3 (Engr. Graphics) or	1	6	3
ME. 10 (Materials & Processes)	2	3	3	ME. 10 (Materials & Processes) or	2	3	3
				CE. 6 (Surveying)	2	3	3
			16				18

Sophomore

Fall Semester	*R*	*L*	*U*	*Spring Semester*	*R*	*L*	*U*
Theol. 7 (Church History I)	2		½	Theol. 8 (Church History II)	2		½
Mil. Sci. 3 (Basic Course)	2	1	1½	Mil. Sci. 4 (Basic Course)	2	1	1½
Math. 4A (Calculus)	3		3	Math. 4B (Calculus)	3		3
Phys. 4B (General Physics)	3	3	4	Phys. 4C (General Physics)	3	3	4
Chem. 4A (General Chemistry)	3	3	4	Chem. 4B (Solid State Chemistry)	3		3
CE. 14 (Mechanics I-Statics)	2		2	CE. 16 Mechanics II-Dynamics)	3		3
Liberal Elective			3	Liberal Elective			3
			18				18

Junior

Fall Semester	*R*	*L*	*U*	*Spring Semester*	*R*	*L*	*U*
Theol. 107 (God & Creation)	2		½	Theol. 108 (The Redeemer and Grace)	2		½
Phil. 61 (Logic)	3		1½	Phil. 62 (Nature and Man)	3		1½
Math. 119 (Diff. Equations)	3		3	EE 136 (Electronics)	3	3	4
CE. 116 (Mech. Materials)	3		3	ME. 123 (Thermo-fluid Mech. II)	3		3
CE. 166 (Materials Lab.)		3	1	ME. 133 (Thermo-fluid Mech. Lab.)		3	1
ME. 121 (Thermo-fluid Mech. I)	3		3	Department Requirements*			8
ME. 131 (Thermo-fluid Mech. Lab.)		3	1				
EE 135 (Elements of E.E.)	3	3	4				
			17				18

	R	*L*	*U*
*CIVIL			
CE 122 (Theory of Structures I)	3		3
CE 172 (Structural Design I)		6	2
CE 110 (Hydraulic Engr.)	3		3
			8

	R	*L*	*U*
*ELECTRICAL			
Technical Elective	3		3
EE 137 (Multimesh Networks)	3		3
EE 138 (Math. of Circuit Anal.)	2		2
			8

	R	*L*	*U*
*MECHANICAL			
ME 118 (Machine Design)	1	6	3
Technical Electives			5
			8

Senior

Fall Semester	*R*	*L*	*U*	*Spring Semester*	*R*	*L*	*U*
Theol. 109 (Sacraments)	2		½	Theol. 110 (Matrimony)	2		½
Phil. 63 (Know. & Reality)	3		1½	Phil. 64 (Ethics)	3		1½
170A (Thesis)			1	170B (Thesis)			1
Dept. Requirements*			15	198 (Seminar)	1		1
				Department Requirements*			14
			18				18

*Civil Engineering

Fall Semester	*R*	*L*	*U*	*Spring Semester*	*R*	*L*	*U*
CE 78 (Geology)	2		2	CE 124 (Reinf. Concrete Des.)	3		3
CE 123 (Theory of Structures II)	3		3	Technical Electives			11
CE 173 (Structural Design II)		6	2				
CE 127 (Soil Mech. & Found. Design)	3		3				
CE 176 (Soil Mech. Laboratory)		3	1				
CE 131 (Sanitary Engr.)	2		2				
CE 142 (Transp. Engr.)	2		2				
			15				14

*Electrical Engineering

Fall Semester	*R*	*L*	*U*	*Spring Semester*	*R*	*L*	*U*
EE 139 (Int. Electronics)	3	3	4	EE 153 (Field Theory)	3		3
EE 152 (Mod. Net Synthesis)	3		3	EE 160 (Control Systems)	3		3
EE 127 (Electro-Mechanical Systems)	3		3	EE 162 (Elect-Mech Lab II)		3	1
EE 161 (Elec-Mech Syst. Lab. I)		3	1	ME 141 (Heat Transfer)	3		3
EE 163 (Elec Comp. Programming)		3	1	Technical Electives			4
Technical Electives			3				
			15				14

*Mechanical Engineering

Fall Semester	*R*	*L*	*U*	*Spring Semester*	*R*	*L*	*U*
ME 119 (Machine Design)	2	3	3	ME 141 (Heat Transfer)	3		3
ME 124 (Thermo-fluids)	3	3	4	Technical Electives			11
ME 144 (Adv. Mechanics)	3		3				
Technical Electives			5				
			15				14

Technical Electives

CIVIL ENGINEERING	R	L	U
CE 143 (Municipal Engr.)	2		2
ME 147 (Metallurgy)	1	3	2
ME 152 (Adv. Fluid Mechanics)	3		3
Math. 110 (Adv. Engr. Math.)	3		3
BA 160 (Ind. Org. and Mgt.)	3		3
Econ. 150 (Labor Problems)	3		3

ELECTRICAL ENGINEERING	R	L	U
EE 128 (Advanced Elec. Mech.)	3		3
EE 140 (Advanced Electronics)	3	3	4
EE164 (Power System Studies)	3		3
EE 165 (Power Networks)	2		2
EE 154 (Microwave Meas.)	2	3	3

Upper Division Math. and Physics courses approved by the Chairman of the Department.

MECHANICAL ENGINEERING	R	L	U
ME 120 (Machine Design)	3		3
ME 134 (Mech. Engr. Experimentation)		3	1
ME 144 (Adv. Mechanics)	3		3
ME 145 (Propulsion Systems)	3		3
ME 147 (Metallurgy)	1	3	2
ME 150 (Heat., Vent. & Air Conditioning)	3	3	4
ME 151 (Adv. Strength of Materials)	3		
ME 152 (Adv. Fluid Mech.)	3		3
Math. 110 (Adv. Engr. Math.)	3		3
Physics 115 (Modern Physics)	3		3
Physics 116 (Physics of Solids)	2		
Physics 120A (Atomic Physics)	3		3
Physics 120B (Nuclear Physics)	3		3
BA 160 (Ind. Org. & Mgt.)	3		3
Econ. 150 (Labor Problems)	3		3

GRADUATE PROGRAM

The Master of Science Program is designed to increase the technical competence of engineers engaged in design, research or development. Candidates are offered a common interest program in mathematics, physics and engineering science. The remainder of each degree program is made up of elective sequences in the area of the candidate's special interest. The M.S. Degree is offered in Civil, Engineering Mechanics, Electrical and Mechanical Engineering. Two unit courses are scheduled in the morning, 7:10 to 9:00.

Admission Requirements

A bachelor's degree in engineering, physics or mathematics normally is required for admission to the Master of Science Program.

Acceptance for Candidacy

Permission to register in the School of Engineering does not in itself imply that the student is accepted, or will be accepted, as a candidate for an advanced degree. Application as a candidate for an advanced degree must be initiated by the student after completing twelve units as a graduate student at Santa Clara. An oral examination covering the student's major area, civil, electrical or mechanical engineering, may be required. At least twelve units must be completed after admission to degree candidacy.

Tuition and Fees

A registration fee of $5.00 is charged for first entrance in the University. This is paid only once. All courses including thesis units will carry a $30.00 tuition fee per semester unit. Auditors will be charged the same fees. For comprehensive written examinations a fee of $10.00 will be charged for each examination.

Program of Studies

A graduate program advisor will be appointed for each degree candidate. A formal program of studies must be filed with the Dean of Engineering along with the application for degree candidacy.

Degree Requirements

The M.S. will be granted to degree candidates after completion of thirty semester credit units, of which six units may be earned by completing the Master's Thesis. Resident requirements of the University will be met by completing twenty units of the graduate program, at Santa Clara, within six calendar years.

DEPARTMENT REQUIREMENTS

Civil Engineering and Engineering Mechanics

The program in Civil Engineering emphasizes the field of Structural Engineering; consequently the degree may be taken in Civil Engineering or Engineering Mechanics. The following courses must be taken by every candidate for the Master's Degree. Adjustment of this requirement may be made in special cases.

CE 206. Theory of Plates.
CE 207. Theory of Shells.
CE 211. Advanced Strength of Materials.
CE 215. Theory of Statically Indeterminate Structures.
CE 216. Advanced Theory of Structures.
CE 218. Dynamics of Structures.
Math. 110A. Advanced Mathematics for Engineers.

Ten units of electives may be selected with department approval.

Electrical Engineering

The following courses must be taken in order to be eligible for the Master's degree in Electrical Engineering. Adjustments of this requirement may be made in special cases.

2 Advanced Mathematics Courses.
2 Advanced Physics Courses.
1 Graduate Course in Electromagnetic Fields.
1 Course in Modern Network Synthesis.
1 Course in Control Systems.

Ten units of electives, selected with the approval of the department, will allow concentration in the following areas of study: networks, controls, electronic circuits, or field theory and applications.

Mechanical Engineering

Candidates for the Master's Degree in Mechanical Engineering should concentrate in one of the three fields listed below. Students are expected to complete most of the courses listed in their field. Programs are to be filled out with additional courses in mathematics, science and engineering with departmental approval.

a) Design Curriculum

ME 205. Physical Properties from the Molecular Viewpoint.
ME 271. Nonlinear Oscillations.
CE 211. Advanced Strength of Materials.
CE 208. Theory of Plasticity.

CE 212. Experimental Stress Analysis.
CE 206. Theory of Plates.
CE 207. Theory of Shells.
CE 215. Theory of Statically Indeterminate Structures.
CE 218. Dynamics of Structures.
ME 144. Advanced Dynamics.

b) Controls and Systems Curriculum

ME 271. Nonlinear Oscillations.
ME 280. Operations Research.
Math. 166. Numerical Analysis.
EE 231. Feedback Control Systems I.
EE 232. Feedback Control Systems II.
EE 241. Computers I.

c) Energy-Mass-Momentum Transfer Curriculum

ME 283. Nuclear Reactors.
ME 285. Gas Dynamics I.
ME 288. Combustion.
ME 289. Advanced Thermodynamics.
ME 291. Advanced Heat and Mass Transfer.
ME 292. Mathematical Hydrodynamics.
ME 293. Boundary Layer Theory.
ME 294. Advanced Propulsion Systems.
ME 295. Magneto-fluid Mechanics.
ME 141. Heat Transfer.
ME 145. Propulsion Systems
ME 152. Advanced Fluid Mechanics.

CIVIL ENGINEERING

Henry V. Hahne, Ph.D.
Chairman of Department

CE 6. Surveying. (3) Surveying instruments, their use, adjustment and care. Basic surveying operations. Methods of evaluation, plotting and adjusting of field data. Principles of topographic mapping. Two hours lecture, three hours field practice.

CE 14. Mechanics (Statics). (2) Fundamental principles of statics. Their application to typical problems in various fields of engineering. Prerequisite: Physics 4A.

CE 16. Mechanics (Dynamics). (3) Fundamental principles of kinematics and dynamics. Dynamics of a particle and dynamics of rigid bodies. Application to problems in engineering. Introduction to theory of vibrations. Prerequisite: CE 14.

CE 78. GEOLOGY. (2) A study of the origin of the earth, the materials and rocks comprising the earth's crust, and the forces and processes acting to shape and modify the landscape and topography. Mineral and rock identification. The uses and applications of topographic and geologic maps. Two hours lecture. Laboratory as required. Prerequisite: Chemistry 4A and 4B.

CE 110. HYDRAULIC ENGINEERING. (3) Flow in channels and pipes. Flow over weirs and through orifices. Hydrology. Flood control, stream regulation, irrigation and drainage. Reservoirs. Dams and hydroelectric power plants. Hydraulic machinery. Waterways and harbor structures. Prerequisite: ME 121.

CE 116. MECHANICS OF MATERIALS. (3) Mechanical properties of engineering materials. Analysis of stresses and deformations. Bars under axial load; torsion; beam bending theory; axial load and bending; Mohrs circle; columns. Prerequiste: CE 14.

CE 121. ENGINEERING ECONOMICS. (3) Definition of economics. Basic concepts. Business units. Money and money systems. Investments. Labor relations. The economics of collectivism. Engineering economy studies. Present worth. Capitalized cost. Depreciation. Engineering reports and budgets. Contracts and specifications.

CE 122. THEORY OF STRUCTURES I. (3) Fundamentals of structural analysis. Determinateness and stability. Analysis of stresses in statically determinate structures under stationary loads. Straight and curved beams. Roof and bridge trusses. Three-hinged arches. Influence lines for beams. Prerequisite: CE 116.

CE 123. THEORY OF STRUCTURES II. (3) Influence lines for bridge trusses and simple arches. Analysis of deformations of structures. Introduction to statically indeterminate structures and the analysis of building frames using moment-distribution method. Prerequisite: CE 122.

CE 124. REINFORCED CONCRETE DESIGN. (3) Basic theory of reinforced concrete. Analysis and design of reinforced concrete structures, such as beams, one-way and two-way slabs, columns, footings, arches and frames: Introduction to elementary concepts of plastic theory and the theory of prestressed concrete. Concrete mixes and construction methods. Prerequisite: CE 123.

CE 127. SOIL MECHANICS AND FOUNDATION DESIGN. (3) A study of the origin, composition and characteristic properties of soils. Theoretical and experimental methods of analysis of the physical properties of soils. Design of earth structures. Principles of foundation design. Introduction to the design and analysis of various types of foundations. Prerequisite: CE 16.

CE 131. SANITARY ENGINEERING. (2) Engineering aspects of water supply, purification and disposal. Occurrence of water; collection, storage and distribution systems for surface and ground water supplies. Hydraulics of sewers. Sewage treatment plants. Introduction to the chemical and biological processes in water purification and sewage treatment. Two hours lecture, laboratory as required. Prerequisite: CE 110.

CE 142. TRANSPORTATION ENGINEERING. (2) Principles of highway planning, economics, finance and design. Curves and earth work. Pavement design and construction. Airports. Introduction to railroad engineering. Design and construction of tunnels. Prerequisites: CE 6 and CE 127.

CE 143. MUNICIPAL ENGINEERING. (2) Principles of city and regional planning. Land use and zoning. Population estimation. Subdivisions. Transportation, traffic and sanitary engineering problems associated with city planning.

CE 166. MECHANICAL PROPERTIES OF MATERIALS LABORATORY. (1) Experimental determination of the mechanical properties of engineering materials in accordance with A.S.T.M., standards. Experimental verification of theory presented in Mechanics of Materials course.

CE 170A. THESIS. (1) The investigation of some engineering problem and the writing of an acceptable thesis under the guidance of an advisor. Prerequisite: Senior standing.

CE 170B. THESIS. (1) Continuation of CE 170A. Prerequisite CE 170A.

CE 170C. THESIS. (1) Continuation of CE 170B. Prerequisite: CE 170B.

CE 172. STRUCTURAL DESIGN I. (2) Fundamentals of structural steel design. Tension members, beams, girders and columns. Riveted and welded connections. Detailing and shop practice. Floor systems and roof trusses. Industrial buildings. Prerequisite: to accompany CE 122.

CE 173. STRUCTURAL DESIGN II. (2) Fundamentals of timber design. Wooden trestles, towers, trusses. Steel bridge design. Truss and plate girder bridges. Highway and railroad bridges. Design of multi-story buildings. Prerequisite: to accompany CE 123.

CE 176. SOIL MECHANICS LABORATORY. (1) Laboratory practice in the examination and testing of the physical properties of soils. Three hours. Prerequisite: to accompany CE 126.

CE 198. SEMINAR. (1) Prerequisite: Senior standing.

CE 199. INDIVIDUAL STUDY. By special arrangement with the Chairman of the Department. Units: arranged.

CE 205. THEORY OF ELASTICITY. (2) Fundamentals of the classical theory of elasticity. Stress and strain in three dimensions. Plane stress and plane strain. Stress function. Problems in rectangular and polar coordinates. Introduction to the use of complex variables. Analysis of stresses around holes, notches and in the vicinity of localized loads. Contact stresses. Torsion of non-circular shafts.

CE 206. THEORY OF PLATES. (2) Methods of analysis of rectangular plates under various loading and support conditions. Fourier series, energy methods and numerical finite difference methods. Analysis of circular plates.

CE 207. THEORY OF SHELLS. (2) Membrane theory of shells of revolution. Cylindrical shells, shell roofs and tanks. Stress function and numerical methods in shell analysis. Introduction to the general bending theory of shells of revolution.

CE 208. THEORY OF PLASTICITY. (2) Analysis of stresses and strains in materials loaded beyond the elastic limit. Perfectly plastic material. Bending of beams and torsion of shafts. Yield hinges, limit analysis, anlaysis of trusses and frames. Shake-down phenomena. Introduction to the mathematical theory of plasticity.

CE 211. ADVANCED STRENGTH OF MATERIALS. (2) Advanced topics in the beam bending theory: bending of beams with nonsymmetrical crossection, principal axes, and principal moments of inertia, shear center, torsion of thinwalled sections, bending and twisting of curved bars, beam on elastic, foundation, beam analysis using Fourier series, non-linear problems in beam bending.

CE 212. EXPERIMENTAL STRESS ANALYSIS. (2) Theory and practice of the photoelastic method for measuring stresses under static and dynamic loads. Moire screen method in photoelasticity. Introduction to three-dimensional photoelasticity. Electrical strain gages and rosettes, and their use in static and dynamic testing. Mechanical and optical strain gages.

CE 215. THEORY OF STATICALLY INTERDETERMINATE STRUCTURES. (2) Analysis of stresses and deformations in statically indeterminate frames, arches and trusses; exact analytical and iterative methods and their application to structural problems. Thermal stresses, and stresses due to shrinkage and creep of structural materials.

CE 217. THEORY OF ELASTIC STABILITY. (2) Stability analysis of elastic bars under axial, and combined axial and laterial loading. Various methods of stability analysis and their limitations. Stability of frames, rings and arches. Stability of twisted bars and lateral stability

of beams. Stability of plates. Introduction to stability of shells. Stability of structures in the inelastic range.

CE 218. DYNAMICS OF STRUCTURES. (2) Analysis of the behavior of structures under dynamic loads. Natural frequencies and modes of beams and shafts. Exact and approximate methods. Dynamics of frames, Analysis of the dynamic behavior of structures in the inelastic range. Theoretical aspects of earthquake analysis.

CE 220. ADVANCED THEORY OF STRUCTURES. (2) Theory of arches. Theory of suspension bridges. Influence lines for stresses and deformation in bridge structures of various types. Secondary stresses in structures.

CE 221. ADVANCED STRUCTURAL DESIGN I (CONCRETE). (2) Design of reinforced concrete arches. Principles of design of shell roofs and tanks. Theory and design of prestressed reinforced concrete structures.

CE 222. ADVANCED STRUCTURAL DESIGN II (STEEL). (2) Advanced topics in the design of bridges and building frames. Analysis and design practice of welded structures.

CE 223. ADVANCED MECHANICAL PROPERTIES OF MATERIALS. (2) Theory of Flow and Fracture of engineering materials. Mechanical properties of engineering materials at low and elevated temperatures. Effect of radiation on mechanical properties.

CE 224. ADVANCED MECHANICAL PROPERTIES OF MATERIALS LABORATORY. (1) Laboratory investigations in creep, fatigue and impact. Non-destructive testing. Three hours laboratory. Prerequisite: to accompany CE 223.

CE 226. ADVANCED SOILS ENGINEERING. (2) Theory of clay mineralogy. Soil compaction characteristics and equipment. Consolidation of soils, time-settlement relationship. Slope and foundation stability. Design, and remedial treatments of soft foundations.

CE 228. ADVANCED SANITARY ENGINEERING. (2) Advanced aspects of the physical, chemical and biological processes involved in water purification and in sewage and waste treatment. Principles of the design and operation of treatment plants. Special aspects of industrial waste treatment.

ELECTRICAL ENGINEERING

HENRY P. NETTESHEIM, M.S.
CHAIRMAN OF THE DEPARTMENT

EE 127. ELECTRO-MECHANICAL SYSTEMS. (3) Introduction to the principles of electro-mechanical energy conversion. Derivation of mathematical models of rotating and translating devices. Development of transfer functions of electro-mechanical devices. Prerequisite: EE 135.

EE 128. ADVANCED ELECTRIC MACHINES. (3) A study of machines particularly applicable to control systems. The analysis of metadyne characteristics, magnetic amplifiers, and translational electromechanical devices is covered extensively. Prerequisite: EE 127.

EE 135. ELEMENTS OF ELECTRICAL ENGINEERING. (4) Fundamental engineering relationships applying to electric, magnetic, and dielectric circuits. Introduction to transformer theory and basic electric machines. Three hours lecture, three hours laboratory. Prerequisite: Physics 9 and concurrent registration or prior completion of Math. 4A.

EE 136. INTRODUCTORY ELECTRONICS. (4) Elementary theory of high vacuum and gas tubes. Solid state devices. Applications to basic electronic circuits as used in communications and industrial systems. Three hours lecture, three hours laboratory. Prerequisites:: EE 135 and Physics 4C.

EE 137. NETWORK ANALYSIS. (3) Principles of multimesh networks including unbalanced polyphase systems. Thorough analysis of these networks to include steady state, transient, and non-sinusoidal conditions. Network and transfer characteristics theorems. Three hours lecture. Prerequisite: EE 135.

EE 138. MATHEMATICS OF CIRCUIT ANALYSIS. (2) Introduction to the operational mathematics of linear system analysis including Fourier and Laplace integrals, convolution integral, and impulse functions. Signal flow graphs and block diagrams. Prerequisite: EE 135.

EE 139. INTERMEDIATE ELECTRONICS. (4) Electron ballistics, emission theory, and transistors theory. Extension of the study of electronic amplifiers to include wide band and radio frequency amplifiers, and the principles and applications of feedback. Polyphase rectifiers and regulated power supplies. Three hours lecture, three hours laboratory. Prerequisites: EE 136, EE 138.

EE 140. ADVANCED ELECTRONICS. (4) Continuation of EE 139 to develop features of oscillators, modulators, and detectors. Amplitude modulation, frequency modulation, and pulse modulation systems. Introduces ultra-high frequency techniques and related circuits. Three hours lecture, three hours laboratory. Prerequisite: EE 139.

EE 152. ADVANCED NETWORK ANALYSIS. (3) Principles of analysis of four terminal networks, including those using distributed parameters. Introduction to the principles of modern network synthesis. Prerequisites: EE 137 and EE 138.

EE 153. ELECTROMAGNETIC FIELD THEORY. (3) Review of electrostatic and magnetostatic fields. Time-varying electromagnetic phenomena. Maxwell's equations in integral and differential forms.

Poynting vector. Transmission, absorption, reflection, and refraction. Three hours lecture. Prerequisites: EE 135, Physics 4C, and Math. 119.

EE 154. MICRO-WAVE MEASUREMENTS AND TECHNIQUES. (3) Traveling waves and reflections in free space, transmission lines, and wave guides. Generation and detection of micro-wave frequencies. Power and impedence. Cavity resonators. Coupling. Antenna radiation pattern measurements. Two hours lecture. Three hours laboratory. Prerequisite: EE 153.

EE 160. AUTOMATIC FEEDBACK CONTROL SYSTEMS. (3) Analysis techniques of servomechanisms and feedback systems. Stability, frequency and time response. Nyquist, Bode, Nichols plots. Root locus. Compensation techniques. Prerequisites: EE 138 and EE 136.

EE 161. ELECTRO-MECHANICAL SYSTEMS LAB I. (1) Tests of electro-mechanical devices. Computer simulation of rotating equipment. Three hours laboratory. Prerequisite: Concurrent or prior registration in EE 127.

EE 162. ELECTRO-MECHANICAL SYSTEMS LAB II. (1) To accompany EE 160. Breadboard tests of servomechanisms and feedback control systems. Analog computer simulation. Three hours laboratory. Prerequisite: EE 163.

EE 163. ELECTRONIC COMPUTER PROGRAMMING. (1) Introduction to analog and digital computer programming. Programming on departmental computers. Combined seminar and laboratory. Three hours weekly. Prerequisites: EE 136 and Math. 119.

EE 164. POWER SYSTEM STUDIES. (3) Study of the mechanical dynamics of electrical machinery as used in electric power networks. Examination of the equal-area criteria, swing curves and other methods of determining system stability under steady state and transient conditions. Three hours lecture. Prerequisites: EE 127 and EE 138.

EE 165. POWER NETWORKS. (2) Principles of symmetrical components and their application to faulted conditions on power network. Study of sequence representation of power networks, polyphase transformer connections, and generator impedances. Introduction to relaying methods of circuit protection. Two hours lecture. Prerequisite: EE 138.

EE 170A. THESIS. (1) Investigation of an approved electrical engineering problem and preparation of suitable thesis covering the investigation. Conferences as required. Prerequisite: Senior standing in Electrical Engineering.

EE 170B. THESIS. (1) Continuation of EE 170A. Prerequisite: EE 170A.

EE 170C. THESIS. (2) Combination of EE 170A and EE 170B. Prerequisite: Senior standing in Electrical Engineering.

EE 198. SEMINAR. (1) Prerequisite: Senior standing.

EE 199. INDIVIDUAL STUDY. By special arrangement with the Chairman of the Department. Credit arranged.

EE 231. FEEDBACK CONTROL SYSTEMS I. (2) Synthesis of linear feedback control systems from closed-loop data. Introduction to statistical methods of analysis of feedback control systems. Prerequisites: EE 138 and EE 160 or equivalents.

EE 232. FEEDBACK CONTROL SYSTEMS II. (2) Sampled-data systems. Analysis of systems operating on discrete signals, applications of continuous system criterion to sampled-data systems. Prerequisites: EE 138 and EE 160 or equivalents.

EE 233. FEEDBACK CONTROL SYSTEMS III. (2) Seminar in modern system synthesis and analysis of sophisticated models. Prerequisites: EE 231 and EE 232.

EE 234. FEEDBACK CONTROL SEMINAR. (2) A series of lectures concerned with the latest developments in the field. Guest lecturers are used. Two hours lecture.

EE 235. NONLINEAR CONTROL SYSTEMS. (2) Graphical and analytical methods of feedback control system analysis. Systems with nonlinearities deliberately introduced to improve performance. Phase space, frequency response, describing functions and small signal theory. Nonlinear transformations and decision functions. Prerequisites: EE 231 and EE 232.

EE 240. ANALOG COMPUTER SIMULATION. (2) Introduction to advanced simulation techniques, statistical analysis methods, function generation. Two hours lecture.

EE 241. COMPUTER I. (2) Introduction to analog and digital computers, theory of computer design, problem set-up, and typical problems analyzed in computer laboratory.

EE 242. THEORY OF COMMUNICATION. (2) Introduction to information transmission, transmission through electronic networks, modulation and modulation systems, periodic sampling and pulse modulation, noise. Prerequisite: EE 138 or equivalent.

EE 243. MODERN NETWORK ANALYSIS. (2) Advanced topics in analysis of passive networks by operational techniques.

EE 244. LINEAR SYSTEM ANALYSIS. (2) Advanced topics in the mathematics of system analysis. Prerequisite: EE 243.

EE 245. NETWORK GRAPH THEORY. (2) The application of linear graph theory to passive network analysis. Two hours lecture. Prerequisites: EE 243 and Math. 105.

EE 246. NETWORK SYNTHESIS I. (2) Advanced treatment of linear passive network theory with primary emphasis on synthesis

aspects, application to design of networks; prescribed transfer and driving-point characteristics, coupling networks, minimum phase and non-minimum phase types, filters, with concern for ultimate response characteristics. Prerequisites: EE 138 and Math. 105 or equivalent.

EE 247. NETWORK SYNTHESIS II. (2) Continuation of EE 246.

EE 248. NETWORK SYNTHESIS III. (2) Continuation of EE 247.

EE 250. ELECTRONIC CIRCUITS I. (2) Study of pulse and switching circuits. Prerequisite: EE 139 or equivalent.

EE 251. ELECTRONIC CIRCUITS II. (2) Transistor electronic circuits, equivalent circuits usable in circuit analysis, use of load-line methods for analysis of common transistor applications. Prerequisite: EE 139 or equivalent.

EE 252. ELECTRONIC CIRCUITS III. (2) Wide band amplifier theory and applications. The use of network theory in analysis and design of wide band amplifiers of the low pass or band pass type. Prerequisites: EE 138 and EE 140 or equivalent.

EE 253. ELECTRONIC CIRCUITS IV. (2) Selected topics in electronic systems. Masers, parametric amplifiers, etc.

EE 254. ELECTRONIC CIRCUITS V. (2) Transistor circuits used in power amplifiers and high frequency applications. Prerequisite: EE 251.

EE 255. ELECTRONIC CIRCUITS SEMINAR. (2) A series of lectures concerned with the latest developments in the field. Two hours lecture.

EE 258. PASSIVE MICROWAVE COMPONENTS. (2) Review of electromagnetic theory fundamentals. High-frequency transmission lines, wave guide modes. Wave guide and coaxial line components. Resonators. Two hours lecture. Prerequisite: EE 260.

EE 259. ACTIVE MICROWAVE COMPONENTS. (2) Microwave detectors, amplifiers, and oscillators. Klystrons, magnetrons, traveling wave tubes, masers, and ferrites. Two hours lecture. Prerequisite: EE 258.

EE 260. FIELDS I. (2) Equations of wave motion, electromagnetic waves, their propagation, interference, and diffraction in free space and conducting medium. Scalar and vector potentials. Radiation, energy, momentum, and radiation-pressure. Prerequisite: EE 153 or equivalent.

EE 261. ANTENNAS. (2) Principles of antenna design and development. Thin linear antennas, loops, helical antennas, reflector types, and arrays. Two hours lecture. Prerequisite: EE 260.

EE 263. INTRODUCTION TO MAGNETOIONIC THEORY. (2) Propagation of electromagnetic waves through ionized media. Effects of steady and varying magnetic fields. Energy absorption, refraction, and reflection. Elements of magneto hydrodynamics. Prerequisite: EE 260.

MECHANICAL ENGINEERING

RICHARD K. PEFLEY, M.S.
CHAIRMAN OF THE DEPARTMENT

ME 3. ENGINEERING GRAPHICS. (3) Principles of orthographic projection and descriptive geometry. Graphic analysis of lines, surface areas, and volumes. Data plotting and determination of elementary empirical equations. One hour lecture, six hours laboratory. Prerequisite: Math. 3A concurrently.

ME 7. ORIENTATION. (0) Discussion of University academic life. History and description of Engineering and its various fields. A series of lectures.

ME 10. MATERIALS AND PROCESSES. (3) Description of physical properties of materials and methods of alteration. Evaluation of these properties by experimentation in heat treatment, casting, machining and welding. Two hours lecture, three hours laboratory.

ME 118. MACHINE DESIGN. (3) Mathematics, statics, dynamics and strength of materials utilized in analytical and graphical analysis of basic machine linkages. One hour lecture and six hours computation. Prerequisite: CE 116.

ME 119. MACHINE DESIGN. (3) Continuation of ME 118 with extension of analysis to include entire machines. Two hours lecture, three hours of computation and analysis. Prerequiste: ME 118.

ME 120. MACHINE DESIGN. (3) Continuation of ME 119 with emphasis on synthesizing. Introduction of advanced methods of stress and deflection analysis. Two hours lecture, three hours of computation and analysis. Prerequisite: ME 119.

ME 121. THERMO-FLUID MECHANICS I. (3) Consideration of Newton's laws of motion, the laws of thermodynamics, and properties of matter with emphasis on the application of these concepts to fluid systems analysis. Three hours lecture. Prerequisite: CE 16.

ME 123. THERMO-FLUID MECHANICS II. (3) Continuation of Me 121 with emphasis on the concepts of the second law of thermodynamics, reversibility, and impulse-momentum in the analysis of heat pump and heat engine processes. Three hours lecture. Prerequisite: ME 121.

ME 124. THERMO-FLUID MECHANICS III. (4) Continuation of ME 123 with emphasis on mixtures of substances, compressible flow,

and combustion. Three hours lecture, three hours laboratory. Prerequisite: ME 123.

ME 131. THERMO-FLUID MECHANICS LABORATORY I. (1) Emphasis placed on dimensional analysis, correct utilization of instruments, data accuracy analysis, and interpretive analysis of results of tests on thermo-fluid systems. Three hours laboratory. Prerequisite: to be taken concurrently with ME 121.

ME 133. THERMO-FLUID MECHANICS LABORATORY II. (1) Continuation of ME 131. Three hours laboratory. Prerequisite: to be taken concurrently with ME 123.

ME 134. MECHANICAL ENGINEERING EXPERIMENTATION. (1) Advanced application of the principles of thermo-fluid mechanics, dynamics and heat transfer to experimental systems. Three hours laboratory. Prerequisite: ME 133.

ME 141. HEAT TRANSFER. (3) An introduction to the concepts of conduction, convection, and radiation heat transfer and application of these concepts to engineering problems. Three hours lecture. Prerequisite: ME 123.

ME 144. ADVANCED MECHANICS. (3) Dynamics of a particle and a system of particles. Lagrangian equations. Applications to engineering problems including vibration and gyroscopic motion. Three hours lecture. Prerequisites: Math. 119, CE 16.

ME 145. PROPULSION SYSTEMS. (3) Common parameters for evaluation of marine, terrestrial and space propulsion systems. Descriptions of types of propulsion systems. Introduction to thermo-fluid analysis of such systems. Three hours lecture. Prerequisite: ME 123.

ME 147. PHYSICAL METALLURGY. (2) Phase equilibria, fundamental structure of metals and alloys, functions of alloying elements in steel, grain size, grain growth, strain hardening, and heat treatment. Two hours lecture. Prerequisite: CE 116.

ME 150. HEATING, VENTILATING AND AIR CONDITIONING. (4) Psychrometry, cooling and heating load computations. Principles of refrigeration. Three hours lecture, three hours laboratory. Prerequisite: ME 141.

151. ADVANCED STRENGTH OF MATERLALS. (3) The analysis of stresses, strains, and deflections in structures and machines. Limitations of the analyses used in elementary strength of materials. Selected topics in the theory of beams, plates and shells, rotating disks, torsion and buckling.

ME 152. ADVANCED FLUID MECHANICS. (3) Application of the principles of thermo-fluid mechanics to selected topics in boundary layer theory, compressible flow, aerodynamics lubrication, and fluid

machinery. Three hours lecture. Prerequisite: ME 123 or concurrent registration.

ME 160. MANAGEMENT ENGINEERING. (3) Consideration of factors relating to plant, product, personnel and profit. Three hours lecture.

ME 170A. THESIS. (1) Investigation of some engineering problem and the writing of an acceptable thesis. Conferences as required. Prerequisite: Senior standing in Mechanical Engineering.

ME 170B. THESIS. (1) Continuation of ME 170A. Prerequisite: ME 170A.

ME 170C. THESIS. (2) Continuation of ME 170A. Prerequisite: ME 170A.

ME 198. SEMINAR. (1) Prerequisite: Senior standing.

ME 199. INDIVIDUAL STUDY. By special arrangement with the Chairman of the Department. Credit arranged.

ME 271. NONLINEAR OSCILLATIONS. (2) Oscillations of nonlinear mechanical and electrical systems. Phase plane, response curves, relaxation oscillations, stability considerations. Two hours lecture. Prerequisites: Math. 119A and ME 144.

ME 273. STATISTICAL ANALYSIS IN ENGINEERING. (2) Combinatorial problems, random variables, distributions, mathematical expectation, descriptive statistics, sampling, statistical inference. Application to engineering problems. Prerequisite: Math. 119 (Ordinary Differential Equations).

ME 275. PHYSICAL PROPERTIES FROM THE MOLECULAR VIEWPOINT. (2) Microscopic theories of deformation and fracture and electrical, thermal, and magnetic properties of materials. Two hours lecture. Prerequisite: Physics 115.

ME 277. CELESTIAL MECHANICS I. (2) Study of the atmosphere, experimental aerodynamics, trajectory mechanics, basic problems of missile and space vehicle performance, static stability and control, and the mechanics of maneuvers.

ME 280. OPERATIONS RESEARCH. (2) Application of mathematical models to industrial problems. Linear programming, queuing and game theory. Two hours lecture. Prerequisite: Math. 119.

ME 283. NUCLEAR REACTORS. (2) Design, kinetics and control of nuclear reactors. Two hours lecture. Prerequisites: Physics 115 and Math. 119.

ME 284. NUCLEAR REACTORS II. (2) Problems in the design of nuclear power plants. Two hours lecture. Prerequisite: ME 283.

ME 285. GAS DYNAMICS I. (2) Flow of compressible fluids including isentropic flow, variable area flow, effects of friction and heat transfer. Wave phenomena. Experimental techniques and measurements. Two hours lecture. Prerequisites: ME 123.

ME 286. GAS DYNAMICS II. (2) Two and three dimensional flow at subsonic and supersonic speeds. Method of characteristics for supersonic flow. Oblique shocks. Prerequisite: Gas Dynamics I.

ME 288. COMBUSTION. (2) Theory of combustion processes. Reaction kinetics, flame propagation theories. Two hours lecture. Prerequisites: Math. 119 and ME 123.

ME 289. ADVANCED THERMODYNAMICS. (2) Thermodynamic functions. Thermodynamics of chemical equilibrium and chemical reactions. Statistical thermodynamics. Two hours lecture. Prerequisites: Math. 119 and ME 123.

ME 290. CONDUCTIVE HEAT TRANSFER. (2) Flow of heat through solid and porous media for steady and transient conditions. Consideration of stationary and moving heat sources. Two hours lecture. Prerequisite: Math. 119.

ME 291. ADVANCED HEAT AND MASS TRANSFER. (2) Advanced problems in heat and mass transfer with emphasis on convection and radiation processes. Two hours lecture. Prerequisite: ME 141 or ME 290.

ME 292. MATHEMATICAL HYDRODYNAMICS. (2) Mathematical analysis of incompressible inviscid flow. Equations of motion, irrotational flow in two and three dimensions, vortex motion, free surface flows. Two hours lecture. Prerequisites: ME 123 and Math. 150B.

ME 293. BOUNDARY LAYER THEORY. (2) Flow of viscous fluids including turbulence and separation effects. Two hours lecture. Prerequisites: Math. 110 and ME 123.

ME 294. ADVANCED PROPULSION SYSTEMS. (2) Advanced topics in the analysis of propulsion systems with emphasis on recently conceived systems. Two hours lecture. Prerequisite: ME 145.

ME 295. MAGNETO-FLUID MECHANICS. (2) Flow of electrically conducting fluids under the influence of electrical, magnetic and mechanical forces. Two hours lecture. Prerequisites: (By arrangement).

ME 297. AERODYNAMIC HEATING. (2) Heat transfer associated with high speed, high altitude aircraft and missiles. Two hours lecture. Prerequisite: ME 141.

ME 298. COMPRESSIBLE AND THERMAL BOUNDARY LAYERS. (2) Continuation of ME 293 with emphasis on compressibility effects. Two hours lecture.

TENTATIVE GRADUATE COURSE SCHEDULE

1962-1963 — Fall

CE 207. Theory of Shells
CE 220. Advanced Theory of Structures.
CE 223. Advanced Mechanical Properties of Materials.
CE 224. Advanced Mechanical Properties of Materials Laboratory.
EE 232. Feedback Control Systems II.
EE 241. Digital Computers.
EE 243. Modern Network Analysis.
EE 246. Network Synthesis I.
EE 250. Electronic Circuits I.
EE 252. Electronic Circuits III.
EE 260. Advanced Field Theory.
ME 271. Nonlinear Oscillations.
ME 283. Nuclear Reactors I.
ME 289. Advanced Thermodynamics.
ME 291. Advanced Heat and Mass Transfer.
Math. 102. Advanced Calculus.
Math. 109. Matrix Theory.
Math. 111 Abstract Algebra.
Physics 115. Modern Physics.
Physics 120A. Atomic Physics.
Physics 130A. Introduction to Mathematical Physics.
Physics 180A. Special Study in Physics.

1962-1963 — Spring

CE 206. Theory of Plates.
CE 211. Advanced Strength of Materials.
CE 212. Experimental Stress Analysis.
CE 215. Theory of Statically Indeterminate Structures.
EE 231. Feedback Control Systems I.
EE 233. Feedback Control Systems III.
EE 242. Theory of Communication.
EE 244. Linear System Analysis.
EE 247. Network Synthesis II.
EE 251. Electronic Circuits II.
EE 253. Electronic Circuits IV.
ME 273. Statistical Analysis in Engineering.
ME 284. Nuclear Reactors II.
ME 285. Gas Dynamics I.
ME 292. Mathematical Hydrodynamics.
Math. 119. Differential Equations.
Math. 160. Introduction to Mathematical Logic.
Physics 116. Physics of Solids.
Physics 120B. Nuclear Physics.
Physics 130B. Introduction to Mathematical Physics.
Physics 180B. Special Study in Physics.

Summer 1963

EE 138. Mathematics of Circuit Analysis.
EE 140. Advanced Electronics.
EE 160. Automatic Feedback Control Systems.
EE 254. Electronic Circuits Seminar.

1963-1964 — Fall

CE 208. Theory of Plasticity.
CE 220. Advanced Theory of Structures.
EE 232. Feedback Control Systems II.
EE 240. Analog Computer Simulation.
EE 241. Digital Computers.
EE 246. Network Synthesis I.
EE 250. Electronic Circuits 1.
EE 252. Electronic Circuits III.
EE 260. Advanced Field Theory.
ME 280. Operations Research.
ME 286. Gas Dynamics II.
ME 293. Boundary Layer Theory.
Math. 103. Vector Analysis.
Math. 105. Introduction to Complex Variables I.
Physics 115. Modern Physics.
Physics 120A. Atomic Physics.
Physics 130A. Introduction to Mathematical Physics.
Physics 180A. Special Study in Physics.

TENTATIVE GRADUATE COURSE SCHEDULE

1963-1964 — Spring

CE 211. Advanced Strength of Materials.
CE 215. Theory of Statically Indeterminate Structures.
CE 223. Advanced Mechanical Properties of Materials.
CE 224. Advanced Mechanical Properties of Materials Laboratory.
EE 231. Feedback Control Systems I.
EE 233. Feedback Control Systems III.
EE 242. Theory of Communication.
EE 247. Network Synthesis II.
EE 251. Electronic Circuits II.
EE 253. Electronic Circuits IV.
EE 258. Microwave Circuits.
ME 271. Nonlinear Oscillations.
ME 273. Statistical Analysis in Engineering.
ME 289. Advanced Thermodynamics.
ME 295. Magneto-Fluid Mechanics.
Math. 106. Introduction to Complex Variables II.
Math. 110. Advanced Engineering Mathematics.
Math. 119. Differential Equations.
Math. 166. Numerical Analysis
Physics 116. Physics of Solids.
Physics 120B. Nuclear Physics.
Physics 130B. Introduction to Mathematical Physics.
Physics 180B. Special Study in Physics.

Summer 1964

EE 138. Mathematics of Circuit Analysis.
EE 140. Advanced Electronics.
EE 160. Automatic Feedback Control Systems.
EE 234. Feedback Control Seminar.

1964-1965 — Fall

CE 205. Theory of Elasticity.
CE 212. Experimental Stress Analysis.
CE 218. Dynamics of Structures.
EE 232. Feedback Control Systems II.
EE 241. Digital Computers.
EE. 243 Modern Network Analysis.
EE 246. Network Synthesis I.
EE 250. Electronic Circuits I.
EE 252. Electronic Circuits III.
EE 260. Advanced Field Theory.
ME 283. Nuclear Reactors I.
ME 285. Gas Dynamics I.
ME 291. Advanced Heat and Mass Transfer.
Math. 102. Advanced Calculus.
Math. 109. Matrix Theory.
Math. 111. Abstract Algebra.
Physics 115. Modern Physics.
Physics 120A. Atomic Physics.
Physics 130A. Introduction to Mathematical Physics.
Physics 180A. Special Study in Physics.

1964-1965 — Spring

CE 208. Theory of Plasticity.
CE 211. Advanced Strength of Materials.
CE 215. Theory of Statically Indeterminate Structures.
CE 217. Theory of Elastic Stability.
EE 231. Feedback Control Systems I.
EE 233. Feedback Control Systems III.
EE 242. Theory of Communication.
EE 244. Linear System Analysis.
EE 247. Network Synthesis II.
EE 251. Electronic Circuits II.
EE 253. Electronic Circuits IV.
ME 273. Statistical Analysis in Engineering.
ME 284. Nuclear Reactors II.
ME 286. Gas Dynamics II.
ME 294. Advanced Propulsion Systems.
Math. 119 Differential Equations.
Math. 160. Introduction to Mathematical Logic.
Physics 116. Physics of Solids.
Physics 120B. Nuclear Physics.
Physics 130B. Introduction to Mathematical Physics.
Physics 180B. Special Study in Physics.

Summer 1965

EE 138. Mathematics of Circuit Analysis.
EE 140. Advanced Electronics.
EE 160. Automatic Feedback Control Systems.
EE 254. Electronic Circuits Seminar.

UNIVERSITY OF SANTA CLARA
IHS
1851